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CURRICULUM GUIDE

FOR

SENIOR HIGH SCHOOL

CHEMISTRY

JUNE 1977

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It is with sincere appreciation that the Curriculum Branch of Alberta Education acknowledges the contributions of the various members of the Chemistry Ad Hoc Committee since it was first recommended by the Secondary School Science Committee on October 24th, 1969.

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NOTE: This curriculum guide is a service publication only. The official statement concerning Senior High School Chemistry is to be found in the Senior High School Program of Studies. The information contained in this guide is prescriptive insofar as it duplicates that which is given in the Program of Studies.

OBJECTIVES OF SECONDARY SCHOOL SCIENCE FOR ALBERTA

The learning of science as an area of human endeavour, should provide the student with a scientific literacy which enables him to assume an active and useful role as a citizen in a democratic society. It may be assumed that this literacy is best achieved by considering the individual needs of students and through independent study and learning.

The objectives of Secondary School Science are:

1. To promote an understanding of the role that science has had in the development of societies:

   a. history and philosophy of science as part of human history and philosophy

   b. interaction of science and technology

   c. effect of science on health, population growth and distribution, development of resources, communication and transportation, etc.

2. To promote an awareness of the humanistic implications of science:

   a. moral and ethical problems in the use and misuse of science

   b. science for leisure-time activities.

3. To develop a critical understanding of those current social problems which have a significant component in terms of their cause and/or their solution:

   a. depletion of natural resources

   b. pollution of water and air

   c. overpopulation

   d. improper use of chemicals

   e. science for the consumer

4. To promote understanding of and development of skill in the methods used by scientists:

   a. processes in scientific inquiry such as observing, hypothesizing, classifying, experimenting and interpreting data

   b. intellectual abilities such as intuition, rational thinking, creativity, and critical thinking

   c. skills such as manipulation of materials, communication, solving problems in groups, and leadership.

5. To promote assimilation of scientific knowledge:

   a. emphasis on fundamental ideas

   b. relevance of scientific knowledge through inclusion of practical applications

   c. application of mathematics in science

   d. interrelationships between the sciences

   e. open-endedness of science and the tentativeness of scientific knowledge.

6. To develop attitudes, interests, values, appreciations, and adjustments similar to those exhibited by scientists at work.

7. To contribute to the development of vocational knowledge and skill:

   a. science as a vocation

   b. science as background to technical, professional and other vocations.

OBJECTIVES OF HIGH SCHOOL CHEMISTRY

In pursuit of scientific literacy, students in a chemistry program should strive to achieve the following objectives:

1. Develop skill in the methods used by chemists such as:

   1.1 processes in scientific inquiry: observing, hypothesizing, classifying, experimenting, and interpreting data.

   1.2 skills in the cognitive, affective, and psycho-motor domains.

   1.3 skills in individual and group problem solving.

2. Acquire a working knowledge of:

   2.1 the fundamental ideas in chemistry

   2.2 the applications of the fundamental ideas

   2.3 the interrelationships among the different sciences and mathematics

   2.4 the tentativeness of chemical theory

3. Acquire a background knowledge about such issues as:

   3.1 use and depletion of natural resources

   3.2 chemistry of environmental pollution

   3.3 use and misuse of chemicals such as preservatives, additives, insecticides, etc.

4. Acquire a background of knowledge and experiences in the application of chemistry such as:

   4.1 chemistry in the home

   4.2 leisure-time activities such as photography, automotives, etc.

   4.3 consumer chemistry

   4.4 chemistry in industry

5. Develop an awareness and critical understanding for decision-making on value issues arising out of the use and misuse of chemistry.

6. Acquire a knowledge and appreciation of the history and philosophy of chemistry.

7. Develop a background of chemical knowledge and skills prerequisite to future careers.

INTRODUCTION

If Chemistry is considered to be a basic science integrating much of man's understanding of nature it seems reasonable to provide a program which is suitable for and which appeals to, a significant portion of the high school population.

To this end the committee has attempted to develop a program which will meet, in a balanced way, the objectives of Secondary School Sciences as published in the Program of Studies for Secondary Schools. We would hope that this program would present Chemistry as a lively, interesting and important part of the scientific adventure which involves, in one way or another, the whole spectrum of society. We seek to show that Chemistry has developed in a very human way with a history of frustration, enlightenment, revision and practical application. Not only have these been aspects of past development but they are very evident in the Chemistry of the present.

As a result of this approach to teaching Chemistry the Committee would hope that the courses would be appealing to a wider segment of the student population than is the case at present. To further this end and also to make the courses more responsive to changing emphases, interests and available materials, we have sought to introduce a certain amount of flexibility into the program. The Committee also feels that this program would continue to apply the process skills emphasized strongly in the Elementary and Junior High Schools.

CHEMISTRY PROGRAM

Program Objectives: Students should develop

1. Scientific process skills.
2. A knowledge of chemistry as a field of study.
3. The ability to analyze current problems and issues.
4. The ability to apply skills and knowledge to real situations.
5. An understanding of the historical antecedents and apply these understandings to current issues.
6. A knowledge of the roles of different individuals in chemical related vocations.

PROGRAM OUTLINE

CHEMISTRY 10

CORE

About 40 hours

1. Basic skills of scientific experimentation.
2. Theoretical bases.
3. Language of Chemistry.

ELECTIVES

(1 or more to be chosen) About 25 hours

- Metallurgy
- Chemicals in the environment
- Chemicals in the marketplace
- Chemistry of Photography
- Locally developed unit

CHEMISTRY 20

CORE

About 40 hours

4. Solutions.
5. Bonding.
6. Organic Chemistry.

ELECTIVES

(One or more to be chosen) About 25 hours

- Polymers
- Biochemistry
- Environmental Chemistry I
- Qualitative Analysis
- Chemistry of the Car
- Locally developed unit

CHEMISTRY 30

CORE

About 75 hours

7. Chemical Change.
8. Proton Chemistry.
9. Redox Reactions.

ELECTIVES

(2 or more to be chosen) About 45 hours

Rates of chemical reactions
Chemical equilibrium
Radiation chemistry
Organic chemistry
Environmental problems
Industrial chemistry and people
Food chemistry
Fossil fuels as energy or feedstock
Locally developed unit

THE TEACHING OF CHEMISTRY

Teaching Procedures

Teachers should familiarize themselves with the objectives to be achieved by the students who study this chemistry program. The particular teaching strategies or approaches to be used by the teacher should be those which will give students a variety of learning experiences focussing on achievement of the objectives. At the same time, a balance must be maintained between theory and application and between inductive and deductive thought processes.

The program is intended to appeal to a wide segment of the student population. However, this should not be misinterpreted to mean that serious study and diligent work on the part of the student is no longer required. Standards can and should be maintained. It is felt that there are a significant number of capable students who are not, for one reason or another, taking chemistry and that they could benefit from doing so.

Concept Formation

It is important for the teacher to remember that concept development is an ongoing process. Generally, it begins for the student as a result of a particular learning "incident". Development comes from a variety of additional learning experiences. The teacher obviously has a most important role in planning for, organizing and presenting these experiences for students but it is the student who must "do the learning".

A highly diversified program emphasizing direct physical experiences reinforced by the use of print and non-print materials and discussion is essential to the development of most concepts. Only then, will early learning form a base for the assimilation of experiences that come later -- experiences that may involve either direct observation (using all the senses) or verbal and pictorial reports of observations made by others.

Use of Textbooks

All too often a textbook has been accepted in many classrooms as the program of studies. Experience has shown that the use of a single text has been inadequate when teachers attempt to meet the range of individual abilities. One must consider both the strengths and limitations of a textbook and exercise discretion in its use. The use of a variety of texts helps to provide alternate methods and approaches to accommodate ranges of performance and interest. No text, manual,

or single aid will provide a creative and appealing approach to instruction for everyone. Students differ and communities are varied, so that the creative ability and background of students demand variation in instructional patterns.

The role of the Laboratory in Chemistry

The challenge of chemistry teaching is to involve the student to the maximum extent possible with the concepts of chemistry. How does one meet this challenge? What activities does one use? How and when should students be involved? What hazards are involved? These and other questions confront every chemistry teacher. The answers that others have found vary according to the goals sought and the personal experience and background of the teacher. There are however, some common elements in the various solutions.

To participate actively in the search for knowledge, the student must have certain skills with respect to the acquisition and the utilization of data. Data collecting in and of itself will serve no useful function. Knowing what data to collect is far more important, but the student cannot know what data to collect until he has gained the skill of proposing the questions that are to be answered. The questions in turn, cannot be proposed until the student is able to evaluate the various components of the environment and critically analyze them in terms of what information will be needed to answer the questions. Having collected the data, the student must then interpret it in an acceptable manner and evaluate it with respect to the methods used in its collection before he can accept or reject his initial solution to the problem.

The laboratory must function to provide the student with the required skills for the generation of knowledge. These skills are vital to the student because of new problems he will be asked to answer and areas of knowledge that will come into existence during his lifetime. It will also provide answers to traditional problems that have been accepted as worthy of answering. The acquisition of knowledge-generation skills must stand as the foremost objective of the laboratory portion of the high school chemistry course.

The new programs utilizing the inquiry approach have developed extensive materials that will assist the teacher in reaching the stated objectives with respect to the laboratory work. These procedures will not be repeated here. Instead, teachers are urged to examine each program's material and apply it as it fits their individual situations.

The high school chemistry course has traditionally been segmented into a lecture portion and a laboratory portion. The lecture has been used primarily to disseminate information. Students have been expected to take notes on the material "covered" in class

and to reproduce that material on tests. Very little opportunity has been given for the frank and open discussion of problems which require knowledge of chemistry and research skills to arrive at viable solutions.

The laboratory portion of the course was initially designed to provide "experiences" whereby the student could come to understand what the research chemist does. Typically, the student starts with a complete set of instructions that inform him of the exact procedures he will use and observations he will make during the laboratory period. He is then provided with questions that require him to fill in the appropriate word in the blank. It is unfortunate that the world does not provide such a convenient format for the research chemist or the scientist!

The function of dispensing information by the teacher is being replaced. The teacher is becoming a designer of environmental encounters. Some psychologicts contend that a student does not truly acquire information that is structured in his mind until he has had the opportunity to act physically upon it. It would follow then, that the more energy the student expends in gathering and processing information the greater would be the probability that it would be incorporated into his cognitive framework in some meaningful fashion. Thus, it should be the role of the teacher to provide as many opportunities as possible for the student to become involved in collecting and organizing information. Students can read faster than the average teacher can speak. It would seem to be advantageous to assign reading that provides the best presentation of the background material the student will need to act on a given problem situation.

Having assigned the information-dispensing responsibility to textbooks or carrel experiences, the teacher must now decide what adequately written objectives will be accomplished in the remaining time. Since science is a problem-solving activity, the time could be spent introducing the students to problem-solving procedures. Problems for consideration may be presented by demonstrations, films or film-loops, or by laboratory activities in which the student defines the problem to be studied and decides on a method for studying that problem.

The amount of time devoted to the laboratory portion of the course will depend on: (a) the syllabus for the course, (b) other teachers giving the same course, (c) the departmental chairman, or (d) the teacher himself. In lieu of other guide lines, it is a common practice to devote approximately 40 percent of the class time to laboratory activities. This may be distributed on a fixed, twice a week schedule, or it may be varied to fit the sequence of instruction.

Laboratory Safety

The prevention of accidents in a laboratory is the responsibility of every individual who enters it. For the teacher, there is a special responsibility to reduce the potential incident that could give rise to injury. In this context laboratory safety is to be a positive component of science teaching and the teacher should stress the importance of careful planning. The result of this part of the chemistry program should be students with safety-conscious attitudes and behaviors. Since students tend to lack the instinctive feeling for investigative work that comes from long-term familiarity with the laboratory, they must be taught how to handle materials which are potentially harmful to them.

The laboratory environment should not be hostile to the student and should be equipped with the appropriate safety devices and materials. For example:

1. If a heating device is to be used then an appropriate fire extinguisher (either CO_2 or dry powder) should be available, or a suitable alternative of a sand bucket, fire blanket, sprinkler or shower bath should be at hand.

2. If corrosive reagents are to be used then a suitable first aid kit and washing facility should be at hand.

3. All flammable or toxic vapor producing reagents should only be used where venting is available and suitable precautions are observed by all participants.

The possibility of accidents and the potential hostility of the chemical laboratory can be reduced by:

1. Storing all corrosive chemicals and flammable solvents as close to the floor as possible in a suitably lined cupboard or cabinet.

2. Not storing reagents which may react violently with each other in close proximity.

3. Storing sodium and potassium under kerosene.

4. Not storing excessively dangerous substances such as white phosphorus, perchloric acid, benzoyl peroxide.

5. Ordering quantities of chemicals and reagents that can be reasonably consumed in the next year. There is some false-economy in storing chemicals over several years if their quality, efficacy or potency changes with time.

6. Storing all chemicals in a secure, well ventilated room in containers that are clearly labelled.

There are many other specific "do's" and "don'ts" related to specific situations and activities. For further guidance, teachers are referred to their school or school jurisdiction's policy or safety handbook. For additional information teachers are also referred to Everett, K. and E. W. Jenkins *A Safety Handbook for Science Teachers, New Edition*. Don Mills: Longman Canada Limited, 1976.

As a closing note, school science laboratories can be as safe a place to teach and learn as any location in the school. This will only be the case through the constant vigilance of teachers and students alike.

THE CURRICULUM STRUCTURE

1. This program is developed on a core-elective method of curriculum organization. Briefly this means that a core occupying fifty to sixty percent of the time allotment will be prescribed for all schools in Alberta. An elective portion of approximately forty to fifty percent of the time will be allowed for modules which take advantage of local interest, expertise, and facilities. It is felt that this approach allows for a number of advantages.

a. It provides for both flexibility and uniformity.

b. Because the core would contain those parts of the course which are relatively constant and the elective modules would contain those parts of current interest, this system of organization would allow for up-dating on a continuous basis.

c. Local interests, facilities, and expertise can be brought into the chemistry program very easily.

d. Modules which involve more than one discipline could be developed. There is a concern that science has become too specialized and modules of this type would counteract this impression.

e. This approach is somewhat adaptable to individualization.

f. This approach also can adapt quite easily to a variety of teaching materials.

2. The basic structure of the chemistry program is a core set of concepts running through the three years of Chemistry 10, 20 and 30, and a minimum of 4 elective modules.

It is the intention that these elective modules accommodate and augment class preferences, individual differences and teacher specialties. In general, the elective modules are to be of about 1 credit's worth of time, although there is no intention to be restrictive in format or in time allotments as long as the objectives are being addressed and met. The intent of this portion of the program is to provide some limited opportunities for modification of the program to suit local needs and at the same time provide a measure of consistency across the province.

3. Some points to keep in mind when using the core-elective program:

a. Care must be taken to ensure that a balanced treatment of the elective objectives is achieved. It is easy to usurp some of the time allotted to elective modules to cover the "more important" core material. The philosophy of the core-elective approach dictates that this be scrupulously avoided.

b. Another underlying advantage of the core-elective approach is its adaptability to change. Those aspects of the program which are most susceptible to change can be placed in the elective part while the more stable aspects can be kept in the core. Care then must be taken to ensure that suitable material is placed in each of these two parts.

c. The elective nature of the program does not imply lack of structure. Structure in the form of objectives and content should be there but not to the detriment of the intent of the program. If opportunity to enhance the program presents itself but requires changing of the organization of the modules the freedom exists to change it. Whether change "in mid-stream" should be made in a module is up to the professional judgment of the teacher.

d. Another underlying advantage is that this kind of curriculum is not dependent on one set of materials but can be taught using a variety of materials available. In fact it can best be taught if there is a variety of materials available.

ELECTIVE MODULES

In choosing modular units the examination of the objectives is of primary importance. In considering the objectives of the modules a number of factors should be considered:

1. Balance of theory vs practical application and a balance in the teaching activities to match the learning styles of the students.

2. Interests of the students.

3. Interests of the teacher.

4. Expertise of the teacher.

5. Facilities and resource materials available.

Objectives should be examined with a view to determining how best to evaluate when these objectives have been achieved. Further care should be taken to ensure that a particular module is compatible with the overall chemistry program.

The above statements should not be misconstrued to give the impression that a great deal of structure is required. The purpose of the module structure is to provide flexibility in the approach to local needs. This should remain upper-most in deciding what is to be covered in the elective portion of the course.

The interdisciplinary possibilities of modules should be actively considered. This is a chance to integrate the various topics of Chemistry as well as to integrate chemistry with other areas of learning, such as Mathematics, English, Social Studies, etc.

CHEMISTRY 10

- OBJECTIVES
- ORGANIZATION
- TEXTS
- CORE

CHEMISTRY 10

OBJECTIVES OF THE CHEMISTRY 10 PROGRAM:

After participating in the activities and completing the requirements of this course, the student should

10.1 Know those concepts of chemistry as specified in the core outline.

10.2 Have competence in the language of chemistry: naming and writing the formulas and chemical equations.

10.3 Be skilled in techniques used by investigators in the field of chemistry.

10.4 Have a background knowledge related to the importance of chemicals and chemical processes in our economy.

10.5 Be aware of the possible harm to the environment which may arise from heavy metals.

10.6 Know the contributions made by various scientific investigators to the topics being studied.

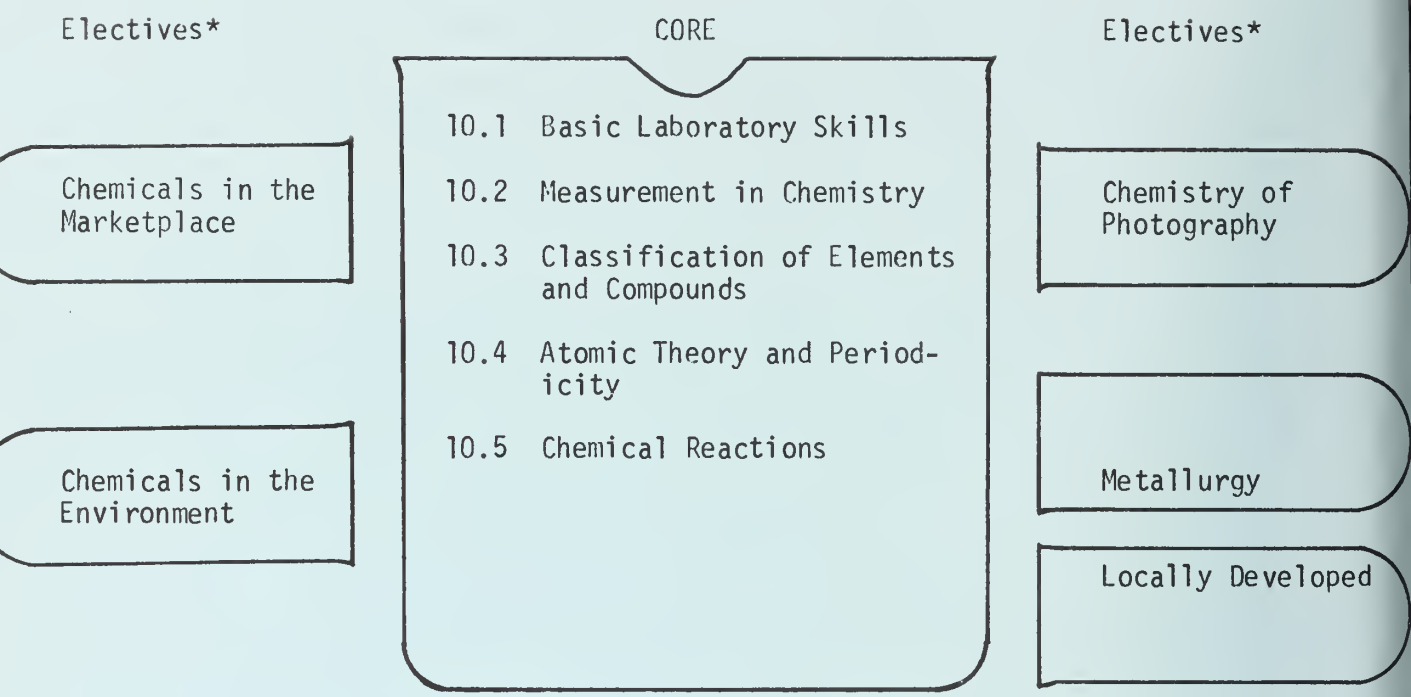
10.7 Be aware of chemistry as a possible vocation and have an appreciation of its association with other sciences.

ORGANIZATION OF PROGRAM:

Approximately 40 hours of instructional time shall be devoted to the core topics and about 25 hours to elective topics. The content of the elective units is to relate to the core in one of three ways:

a. an extensive study of a core topic
b. an in-depth, intensive study of a core topic, or
c. a practical application of a core topic

CHEMISTRY 10



Time allocations: about 40 hours for the core
about 25 hours for electives

*At least one elective area is to be explored. The outlines are provided in the Curriculum Guide with a list of references.

Prescribed Core References

Ledbetter, E. W. and J. A. Young, *Keys to Chemistry* Don Mills: Addison-Wesley, 1977

Ledbetter, E. W. and J. A. Young, *Laboratory Keys to Chemistry*, Don Mills: Addison-Wesley, 1977
or:
Jenkins, F. et al, *ALCHEM 10*. Edmonton: E.P.S. District #7, 1976

Recommended Core References

Courneya, D. and H. McDonald, *The Nature of Matter*, Toronto: D. C. Heath and Company, 1976

Whitman, R. L. and E. E. Zinck, *Chemistry Today*, Scarborough: Prentice-Hall Canada, 1976

IAC Modules:
Atkinson, G. and H. Heikkinen, *Reactions and Reason.*
Huheey, J. *Diversity and Periodicity*
Don Mills: Fitzhenry and Whiteside (Harper & Row), 1973

Recommended Elective References (in addition to those listed above)

Worthington, G., *Chemistry of Metallurgy*, Agincourt: Book Society, 1977

Birenbaum, L., *Chemistry of Man and Molecules*. Agincourt: Book Society, 1975

Ashcroft, K., *Chemistry of Photography*. Agincourt: Book Society, 1976

Gordon, G. and W. Zoller, *Chemistry in Modern Perspective.*
Don Mills: Addison-Wesley, 1975

OUTLINE OF CHEMISTRY 10 CORE

Concepts:	Subconcepts:
10.1 The activities of chemical laboratory experimentation require basic skills and knowledge.	10.1.1 Various techniques are used to make qualitative and quantitative observations.
	10.1.2 Safety is of prime importance in the laboratory.
	10.1.3 Laboratory investigations follow a pattern involving such skills as hypothesizing, observing, interpreting, etc.
	10.1.4 The use of graphs in science enable the scientist to relate the variables of an experiment.
10.2 Measurement units are used to describe the properties of matter.	10.2.1 The development of the International System of Units (SI) provides a logical and consistent measurement of length, mass, time, quantity and temperature.
	10.2.2 The use of significant figures in measurements and calculation is a method of indicating precision.
10.3 Matter is classified in a variety of ways.	10.3.1 Matter is classified on the basis of physical and chemical properties.
	10.3.2 Changes in matter are classified as being physical and/or chemical.
	10.3.3 Matter may be classified as:
	10.3.3.1 Mixtures or pure substances.
	10.3.3.2 Homogeneous or heterogeneous.
	10.3.3.3 Metals or non-metals.
	10.3.3.4 Ionic or molecular.
10.4 The present atomic theory was developed on the basis of the accumulation of physical and chemical evidence.	10.4.1 Many scientists contributed to the development of modern atomic theory.
	10.4.2 Structure of an atom consists of a dense, positively charged nucleus surrounded by electrons.

		10.4.3 The periodic table is a classification of the elements on the basis of their chemical and physical properties and atomic structure.
10.5	Chemical reactions may be classified and are represented by a chemical language.	10.5.1 IUPAC rules provide a consistent system for naming chemical substances and writing formulas for them.
		10.5.2 The "mole" is a quantity of matter (6.02×10^{23} particles).
		10.5.3 Chemical reactions may be represented by balanced chemical equations.
		10.5.4 Chemical reactions may be classified according to type of reaction.
		10.5.5 The writing and interpretation of balanced chemical reaction is based on the law of Conservation of Mass.
		10.5.6 Chemicals and chemical reactions have many effects: environmental, economic, industrial, etc.

CHEMISTRY 10 ELECTIVE TOPICS

Elective topics are to be chosen from the following list. A minimum of one topic is to be studied.

10.1 Metallurgy

10.2 Chemicals in the Environment

10.3 Chemicals in the Marketplace

10.4 Chemistry of Photography

10.5 Locally Developed Unit

CONCEPT REFERENCE GRID KEYED TO PRESCRIBED REFERENCES

CONCEPTS		Keys to Chemistry (Sections)	Keys to Chemistry Objectives	ALCHEM (Pages)	ALCHEM Objectives
10.1 The activities of chemical laboratory experimentation require basic skills and knowledge.	10.1.1 Various techniques are used to make qualitative and quantitative observations.	L.M. pp 7-10 Exp. 1-2 (All Exp's)	1	Lab D1 (all labs)	1
	10.1.2 Safety is of prime importance in the laboratory.	L.M. pp 4	1	Lab A1	1
	10.1.3 Laboratory investigations follow a pattern involving such skills as hypothesizing, observing, interpreting, etc.	1-1,1-2,5-1 Exp 1-1 Exp 5-1	1	all labs (eg Lab C3)	1
	10.1.4 The use of graphs in science enable the scientist to relate the variables of an experiment.	1-9, 1-10 Exp 1-3	1		
10.2 Measurement units are used to describe the properties of matter.	10.2.1 The development of the international System of units (SI) provide a logical and consistent measurement of length, mass, time, quantity & temperature.	1-6, 1-7, Appx 1	2	D1-D2, D4	2, 4
	10.2.2 The use of significant figures in measurements and calculation is a method of indicating precision.	1-8 Appx 3	1	D3-D6	1
10.3 Matter is classified in a variety of ways.	10.3.1 Matter may be classified on the basis of physical and chemical properties.	1-3,1-11,2-1 Exp 2-1 Exp 2-2	1,2	B1 Lab A2, Lab B2	1,2,3,4
	10.3.2 Changes in matter are classified as physical and/or chemical.	2-2, 1-4 Exp 2-3	1,2	A13-A16 Lab C1	1,2,4
	10.3.3 Matter may be classified as mixtures or pure substance; homogeneous or heterogeneous, metal or nonmetal; and ionic or molecular, elements or compounds.	2-3,2-4,2-5 Exp 2-4	1,2	A4, A13 Lab A2, Lab B2 B1,B4,B8	1,2,4
10.4 The present atomic theory was developed on the basis of accumulating physical and chemical evidence.	10.4.1 Many scientists contributed to the development of the modern atomic theory.	5-2,5-3,5-4 5-6,5-8, 5-12,5-14	1,2,6	A27, A30 D8	2,6
	10.4.2 The structure of the atom consists of a dense, positively charged nucleus surrounded by electrons.	5-8, 6-1	2,6	A27-A30	2,6
	10.4.3 The periodic table is a classification the elements on the basis of their chemical and physical properties and atomic structure.	6-6,to 6-8 Exp 6-2	1,2,6	Lab A2, A4, A10, A16, A27-A39	1,2,4,6
10.5 Chemical reactions may be classified and may be represented by a chemical equation.	10.5.1 IUPAC rules provide a consistent system for naming chemical substances and writing formulas for them.	8-3,8-4,2-8 8-5,8-6 Apdx 4,5, &6	2	A5-A8 Unit B	2,4,6
	10.5.2 The mole is a quantity of matter (6.02×10^{23} particles)	8-1,8-2,8-7	2	Unit C Unit D Unit E	2,4,6
	10.5.3 Chemical reactions may be represented by balanced chemical equations.	8-8 Apdx 7	2	C5 Lab C2 Unit C Unit E	1,2,3,4 5,6,7
	10.5.4	8-10 Exp 8-3	1,2	C9 & on thru unit C and Unit E	1,2,3,4 5,6,7
	10.5.5 The writing and interpretation of balanced chemical equations is based on the law of conservation of mass.	8-9 Exp 8-4 Apdx 10	1,2	Unit C Unit E	1,2,3,4 5,6,7
	10.5.6 Chemicals and chemical reactions have many effects: environmental, economic industrial, etc.	Keys to Environmental Chemistry		Nearly all questions and labs Units A-E	3,4,5,6,7

Chemistry 10
Electives

CHEMISTRY 10 ELECTIVE MODULES

The listing of these modules is not intended to ve very extensive or exclusive. The teacher is quite free to use other ideas or elective modules.

The principles underlying the choice of modules are:

1. The time available is of the order of 25 hours.

2. The content is related to the core in one of three ways:

   a. an extension of a core topic
   b. an indepth, intensive study of a core topic, or
   c. a practical application of a core topic

Elective topics are to be chosen from the following list. A minimum of one topic is to be studied.

10.1 Metallurgy . . . . . p. 25

10.2 Chemicals in the Environment . . . p. 26

10.3 Chemicals in the Marketplace . . . p. 27

10.4 Chemistry of Photography . . . . . p. 28

Metallurgy

INTENT

To have students:
Develop an appreciation of the historical development of metallurgy.
Obtain an understanding of how some metals are refined from their ores.
Acquire knowledge of the chemical processes involved in various aspects of the metallurgical industry.

CONTENT

1. Metals in history
2. Mining ore from deposits
3. Concentration of metallic ore
4. Refining a metal from its ore
5. Uses of metals - pure metals
   - alloys
6. Corrosion of metals

REFERENCES

1. Courneya, D. and H. McDonald, *The Nature of Matter*. Toronto: D. C. Heath, 1976, Chapter 5.
2. Worthington, G., *Chemistry of Metallurgy*. Agincourt: Book Society, 1977.
3. Jones, M. M. et al, *Chemistry, Man and Society, Second Edition*. Toronto: W. B. Saunders, 1976, Chapter 12.
4. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today*. Agincourt: Gage and Co., 1973, Chapter 15.

Chemicals in the Environment

INTENT

To have students:
Realize their responsibility in maintaining the quality of their environment.
Acquire knowledge about the problems and proposed solutions.

CONTENT

1. Air contaminants
   - solid particles
   - gases and vapors
   - greenhouse and photochemical effects
   - solutions
2. Water contaminants
   - bacteriological pollution
   - chemical pollution
   - thermal pollution
   - purification and disposal technologies

REFERENCES

1. Pryde, L. T. et al, *Keys to Environmental Chemistry.* Don Mills: Addison-Wesley, 1975.
2. Whitman, R. L. and E. E. Zinck, *Chemistry Today.* Scarborough: Prentice-Hall, 1976. Chapter 15.
3. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today.* Agincourt: Gage and Co., 1973.
4. Gordon, G. and W. Zoller, *Chemistry in Modern Perspective.* Don Mills: Addison Wesley, 1975, Chapters 9, 10-8, 10-9, 11-6, 13-12, 14.
5. Hammill, J., *Water, Chemistry and Ecology.* Agincourt: Book Society, 1974.

Chemicals in the Marketplace

INTENT

To have students:
Gain an understanding of some of the chemical reactions involved in the production or processing of items and products commonly found in the home.
Recognize the ecological implications of using and disposing of such products.

CONTENTS

1. Plastic and fabrics
2. Drugs and vitamins
3. Soaps and detergents
4. Cosmetics, perfumes and aerosols
5. Rubber and polyvinyl chloride
6. Pesticides

REFERENCES

1. Courneya, D. and H. McDonald, *The Nature of Matter*. Toronto: D. C. Heath, 1976, Chapter 7.
2. Birenbaum, L., *Chemistry of Man and Molecules*. Agincourt: Book Society, 1975.
3. Gordon, G. and W. Zoller, *Chemistry in Modern Perspective*. Don Mills: Addison-Wesley, 1975, Chapters 13 and 15.
4. Kowalski, W., *Consumer Science*. Dubuque: Kendall/Hunt Publishing, 1975, pp. 100-115, 173-187.

Chemistry of Photography

INTENT

To provide students with an experience in the practical applications of laboratory procedures and to provide a lasting, valuable, set of skills that are of use to the student in his personal life.

CONTENT

1. Steps in producing photographic prints:
   - exposing the film
   - developing the negative
   - making the print
2. Structure of photographic film
3. Processing the film:
   - developing the negatives
   - contact prints
   - enlarging
4. Making acceptable prints and slides

REFERENCES

1. Ashcroft, K., *Chemistry of Photography*. Agincourt: Book Society, 1976.
2. Hattersley, R., *Beginner's Guide to Photography*. Toronto: Doubleday of Canada, 1974.

CHEMISTRY 20

- OBJECTIVES
- ORGANIZATION
- TEXTS
- CORE

CHEMISTRY 20

OBJECTIVES OF THE CHEMISTRY 20 PROGRAM:

After participating in the activities and completing the requirements of this course, the student should:

20.1 Know the chemical principles underlying the chemistry specified in the core outline.

20.2 Be skilled in using proper laboratory techniques used by chemists and laboratory personnel.

20.3 Comprehend the historical development of the chemistry principles being studied.

20.4 Have the capacity to apply the knowledge and skills of chemistry to other situations involving chemicals at home and in industry.

20.5 Have interests and attitudes toward chemistry that will assist in the choice of vocations.

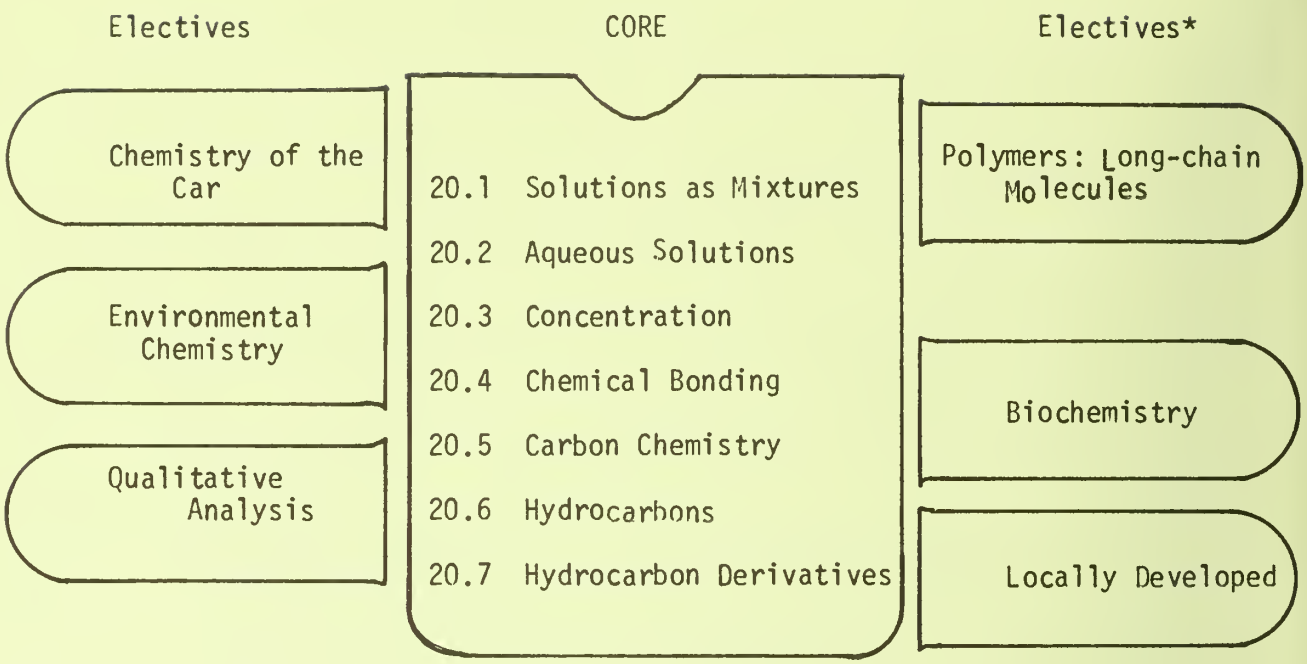
20.6 Know the chemistry facts and principles related to the open discussion of social issues of current interest.

ORGANIZATION OF PROGRAM:

Approximately 40 hours of instructional time shall be devoted to the core topics and about 25 hours to elective topics. The content of the elective units is to relate to the core in one of three ways:

a. an extensive study of a core topic
b. an in-depth, intensive study of a core topic, or
c. a practical application of a core topic

CHEMISTRY 20



Time allocations:
about 40 hours for the core topics
about 25 hours for the elective topics

*At least one elective area is to be explored. The outlines are provided in the Curriculum Guide with a list of references.

CHEMISTRY 20

Prescribed Core References

Ledbetter, E. W. and J. A. Young, *Keys to Chemistry*.
Don Mills: Addison-Wesley, 1977

Ledbetter, E. W. and J. A. Young, *Laboratory Keys to Chemistry*.
Don Mills: Addison-Wesley, 1977

Gortler, L. B. et al, *Keys to Organic Chemistry*.
Don Mills: Addison-Wesley, 1977
or:
Jenkins, F. et al, *ALCHEM 20*. Edmonton: E.P.S. District #7, 1977

Recommended Core References

Courneya, D. and H. McDonald, *The Nature of Matter*. Toronto:
D. C. Heath and Company, 1976

Whitman, R. L. and E. E. Zinck, *Chemistry Today*. Scarborough:
Prentice-Hall, Canada, 1976

IAC Modules

Atkinson, G. and H. Heikkinen, *Reactions and Reason*
Huheey, J., *Diversity and Periodicity*
DeVoe, H., *Communities of Molecules*
Jarvis, B. and P. Mazzocchi, *Form and Function*
Don Mills: Fitzhenry and Whiteside (Harper and Row), 1973

Recommended Elective References (in addition to those listed above)

Gordon, G. and W. Zoller, *Chemistry in Modern Perspective*. Don Mills:
Addison-Wesley, 1975

Martin, D. and J. Sampugna, *Molecules in Living Systems*. Don Mills:
Fitzhenry and Whiteside (Harper and Row), 1973

Hammill, J. *Water, Chemistry and Ecology*. Agincourt:
Book Society, 1974

Gordon, G., *The Delicate Balance*. Don Mills: Fitzhenry and Whiteside
(Harper and Row), 1973

Ashcroft, K. and J. Hammill, *Chemistry of the Car*. Agincourt Book
Society, 1976

Pryde, L. T. et al, *Keys to Environmental Chemistry*.
Don Mills: Addison-Wesley, 1975

OUTLINE OF CHEMISTRY 20 CORE

SOLUTIONS

Concepts:	Subconcepts:
20.1 Solutions are mixtures.	20.1.1 Solutions are homogeneous mixtures of solute(s) and a solvent.
	20.1.2 Solutions may be composed of combinations of solids, liquids and gases.
20.2 Formation of aqueous solutions is a chemical reaction.	20.2.1 Aqueous solutions play a very important part in chemistry.
	20.2.2 The dissolving of a solute in a solvent results in ions or molecules in solution, and involves energy changes.
	20.2.3 Solutions may be classified as electrolytes or non-electrolytes.
20.3 The proportion of solute to solvent is represented by the concentration.	20.3.1 Concentration of solutions is defined in terms of moles of solute per litre of solution, or moles of solute per cubic metre of solution.
	20.3.2 Concentration and changes in concentration in solutions can be derived mathematically.
	20.3.3 Solutions may be described as: unsaturated, saturated, supersaturated.
	20.3.4 Solubility is the concentration of a solute in a saturated solution and is in an equilibrium condition.
	20.3.5 Factors that affect solubility are: nature of solute and solvent, temperature and pressure.

BONDING

Concepts:	Subconcepts:
20.4 Chemical substances exist as elements bonded together.	20.4.1 Chemical bonds may be covalent or ionic.
	20.4.2 Molecules formed by covalent bonds may be polar or nonpolar.
	20.4.3 Bonding between molecules may be classified as dipole-dipole, or hydrogen bonding.

ORGANIC CHEMISTRY

Concepts:	Subconcepts:
20.5 Organic chemistry can be termed "Carbon Chemistry".	20.5.1 The carbon to carbon bonding results in a great variety of compounds.
	20.5.2 Carbon compounds are some of the most important substances on earth.
20.6 Hydrocarbon compounds form an important group of chemicals.	20.6.1 Hydrocarbons may be classified structurally as aliphatic or aromatic.
	20.6.2 The chemical and physical properties of hydrocarbons are the result of their structure and composition.
	20.6.3 Hydrocarbon reactions can be classified as combustion, substitution, and addition.
	20.6.4 The hydrocarbons are an important component of industry in Alberta.
20.7 Hydrocarbon derivatives form another important group of chemicals.	20.7.1 Major derivatives of hydrocarbons are alcohols, carboxylic acids, and esters.
	20.7.2 The chemical and physical properties of these derivative compounds are the result of their structure and composition.

CONCEPT REFERENCE GRID KEYED TO PRESCRIBED REFERENCES

CONCEPTS		SUBCONCEPTS	KEYS TO CHEMISTRY (Sections)	Objectives	ALCHEM (pages)	Objectives
20.1 Solutions are mixtures	20.1.1	Solutions are homogeneous mixtures of a solute(s) and a solvent.	3-6, 3-7	2	I1	2
	20.1.2	Solution may be composed of combinations of solids, liquids and gases.	3-8	2,4		
20.2 The formation of aqueous solutions is a chemical reaction	20.2.1	Aqueous solutions play a very important part in chemistry	3-6	2	I1	2
	20.2.2	The dissolving of a solute in a solvent results in ions or molecules in solution and involves energy changes.	3-9,3-11,10-9, Exp. 3-3,3-4	1,2,4	I23, I25	2, 4, 6
	20.2.3	Solutions may be classified as electrolytes or nonelectrolytes	3-15, 4-1,4-2 Exp. 4-1, 10-10	1,2,6	I23, I25	1, 2, 6
20.3 The proportion of solute to solvent is represented by the concentration	20.3.1	Concentration of solutions is defined in terms of moles of solute per litre,or moles of solute per cubic metre of solution.	3-10 Exp. 10-3	1,2	I1-I14, I21, I22	1, 2, 4, 5
	20.3.2	Concentration and changes in concentration can be derived mathematically	3-10	2	I1-I22	2
	20.3.3	Solutions may be described as unsaturated, saturated, or super-saturated.	3-12 Exp. 3-5	1,2	I31	1,2
	20.3.4	Solubility is the concentration of a solute in a saturated solution and is an equilibrium condition	3-12	2	I32-I37	1,2
	20.3.5	Factors that affect solubility are the nature of solute and solvent, temperature, and pressure.	3-13, 3-14	2,4	I38, Lab I2	1,2, 4
20.4 Chemical substances exist as elements bonded together	20.4.1	Chemical bonds may be covalent or ionic.	7-1,7-2,7-3	2	G1-G8, G33	2,6
	20.4.2	Molecules formed by covalent bonds may be polar or non polar.	7-3	2	G9-G21	2
	20.4.3	Bonding between molecules may be classified as dipole-dipole or hydrogen bonding.	7-5 Exp. 7-1,7-2	1,2	G22-G31	2,4, 6
20.5 Organic chemistry can be termed "Carbon Chemistry"	20.5.1	The carbon to carbon bonding results in a great variety of compounds.	*1-2,1-5	1,2,3	H1-H32	1,2,3,4, 6
	20.5.2	Carbon compounds are some of the most important substances on earth.	*1-1,1-3,1-4	1,2	H1, H3,H7-H10 H21,H26,H33-H35	2,4
20.6 Hydrocarbon compounds form an important group of chemicals	20.6.1	Hydrocarbons may be classified structurally as aliphatic or aromatic.	*2-2 to 2-5	1,2,4	H1 to H39	1,2,7
	20.6.2	The chemical and physical properties of hydrocarbons are the result of their structure and composition.	*2-1,2-6,2-7, 4-1 to 4-7	1,2,4,5	H1 to H39	1,2, 4
	20.6.3	Hydrocarbon reactions can be classified as combustion, substitution, and addition.	*2-2, to 2-5	1,2,4	H1-H39	1,2,4
	20.6.4	The hydrocarbons are an important component of industry in Alberta.	*2-6, 2-7	2,6,7	H8,H26 , H33 H33, H35, H42	2,4,7
20.7 Hydrocarbon derivatives form another important group of chemicals	20.7.1	Major hydrocarbon derivatives are alcohols, carboxylic acids, and esters.	*3-1, 3-2, 3-6, 3-7	1,2,4	H45-H60	1, 2, 4
	20.7.2	The chemical and physical properties of these derivative compounds are the result of their structure and composition.	*4-1, to 4-7	1,2	H45-H60	1,2,4

*Keys to Organic Chemistry

Chemistry 20
Electives

CHEMISTRY 20 ELECTIVE MODULES

The listing of these modules is not intended to be very extensive or exclusive. The teacher is quite free to use other ideas for elective modules.

The principles underlying these choices are:

1. The time available is of the order of 25 hours.

2. The content is related to the core in one of three ways:
   a. an extension of a core topic.
   b. an indepth, intensive study of a core topic, or
   c. a practical application of a core topic.

Elective topics are to be chosen from the following list. A minimum of one topic is to be studied.

20.1 Chemistry of the Car. . . . . p. 38

20.2 Environmental Chemistry . . . . . p. 39

20.3 Polymers: Long Chain Molecules. . . p. 40

20.4 Biochemistry. . . . . p. 41

20.5 Qualitative Analysis. . . . . p. 42

20.6 Locally Developed Unit

Chemistry of the Car

INTENT

To have students:
Relate the chemistry they learn in the classroom to a physical "system" that has come to be an important influence in North American lifestyles.

CONTENT

1. Components of an automobile.
2. Chemistry of fuel.
3. Engine reactions.
4. Corrosion reactions.

REFERENCES

1. Ashcroft, K. and J. Hammill, *Chemistry of the Car*. Agincourt: Book Society, 1976.
2. Gordon, G. and W. Zoller, *Chemistry in Modern Perspective*. Don Mills: Addison-Wesley, 1975, Chapter 14.

Environmental Chemistry

INTENT

To have students:
Present an objective assessment of major sources of pollution.
Identify and evaluate proposed solutions to certain environmental problems caused by the indiscriminant use of chemicals.

CONTENT

1. Major environmental problems:
   - man and technology
2. Waste disposal technologies
3. Chemical aspects of water pollution:
   - dissolved gases
   - pH and hardness
   - chemical contaminants
   - water quality standards
4. Air contamination:
   - particulates
   - gases and vapors
   - air quality standards
5. Purification technology

REFERENCES

1. Pryde, L. T., *Environmental Chemistry: An Introduction.* Don Mills: Addison-Wesley, 1973.
2. Andrews, W. A., *Environmental Pollution.* Scarborough: Prentice-Hall, 1972.
3. Jones, M. M., *Chemistry, Man and Society. Second Edition.* Toronto: W. B. Saunders, 1976, Chapters 11, 18, 19 and 20.
4. Gordon, G. and W. Zoller, *Chemistry in Modern Perspective.* Don Mills: Addison-Wesley, 1975, Chapters 1, 9, 10, 11, and 12.
5. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today.* Agincourt: Gage and Co., 1973, Chapters 21 and 22.

Polymers -- Long Chain Molecules

INTENT

To have students:
Develop an understanding of the reactions involved in the production of polymers from the raw materials to the consumer product.
Realize that many of our commonly-used consumables are bought at a high energy cost.

CONTENT

1. Monomers and polymers
2. condensation reactions
3. Addition reactions
4. Properties of polymers
5. Industrial processes

REFERENCES

1. Gortler, L. B. et al, *Keys to Organic Chemistry*. Don Mills: Addison-Wesley, 1976, Part 5.
2. Vallarino, L. M. and J. M. Quagliano, *Chemistry A Humanistic Approach*. Toronto: McGraw-Hill, 1975, Chapter 15.
3. Gordon, G. and W. Zoller, *Chemistry in Modern Perspective*. Don Mills: Addison-Wesley, 1975, Chapter 13.
4. Jarvis, B. and P. Mazzocchi, *Form and Function*. Don Mills: Fitzhenry and Whiteside (Harper & Row), 1973, 036 to 041
5. Jones, M. M., et al, *Chemistry, Man and Society, Second Edition*. Toronto: W. B. Saunders, 1976, Chapter 15.
6. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today*. Agincourt: Gage and Co., 1973, Chapter 20.

Biochemistry

INTENT

To have students:
Learn the interrelationships between chemistry and biology.
Apply the concepts learned in chemistry to the study of a living system.

CONTENT

1. Carbon compounds found in living organisms:
   - fats, carbohydrates, sugars and proteins
2. Chemical reactions in living organisms:
   - photosynthesis, metabolism
   - catalysts and inhibitors in the body - enzymes and hormones
3. Drugs and medications

REFERENCES

1. Whitman, R. L. and E. E. Zinck, *Chemistry Today*. Scarborough: Prentice-Hall, 1976, Chapter 14.
2. Vallarino, L. M. and J. M. Quagliano, *Chemistry: A Humanistic Approach*. Toronto: McGraw-Hill, 1975, Chapter 13.
3. Gordon, G. and W. Zoller, *Chemistry in Modern Perspective*. Don Mills: Addison-Wesley, 1975, Chapter 15.
4. Martin, D. and J. Sampugna, *Molecules in Living Systems*. Don Mills: Fitzhenry & Whiteside (Harper & Row), 1973.
5. Jones, M. M. et al, *Chemistry, Man and Society, Second Edition*. Toronto: W. B. Saunders, 1976, Chapters 16 and 17.
6. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today*. Agincourt: Gage and Co., 1973, Chapters 23, 24, 25 and 26.

Qualitative Analysis

INTENT

To have students:
Exhibit some skill in the techniques of basic analytic techniques.
Perform some elementary identification procedures.
Write balanced equations describing the reactions.

CONTENT

1. Principles of qualitative analyses.
2. Laboratory precautions and needed skills.
3. Reporting techniques.
4. Cation and anion tests.

REFERENCES

1. Ledbetter, E. W. and J. A. Young, *Keys to Chemistry*. Don Mills: Addison-Wesley, 1977, Chapter 11.
2. Huheey, J., *Diversity and Periodicity*. Don Mills: Fitzhenry and Whiteside (Harper & Row), 1973, I 29 - I 39.
3. DeVoe, H., *Communities of Molecules*. Don Mills: Fitzhenry and Whiteside (Harper & Row), 1973, P 34 - P 38.

CHEMISTRY 30

- OBJECTIVES
- ORGANIZATION
- TEXTS
- CORE

CHEMISTRY 30

OBJECTIVES OF THE CHEMISTRY 30 PROGRAM:

After participating in the activities and completing the requirements of this course, the student should:

30.1 Know the facts and principles of chemistry as specified by the core outline.

30.2 Have competence in using the processes and techniques of chemistry in the identification of problems and the testing of proposed answers.

30.3 Be aware of the chemical factors related to issues of current interest.

30.4 Be informed about vocational and career opportunities in the chemical and technical fields.

30.5 Know the contributions that various investigators have made in the development of current chemical theories.

30.6 Understand the application of the concepts and principles learned in class to the production and use of such products as ethylene, gasoline, plastics, fertilizers, pesticides and foods.

ORGANIZATION OF PROGRAM:

Approximately 75 hours of instructional time shall be devoted to the core topics and about 45 hours to elective topics. The content of the elective units is to relate to the core in one of three ways.

a. an extensive study of a core topic
b. an in-depth, intensive study of a core topic, or
c. a practical application of a core topic.

CHEMISTRY 30

Electives*

- Rates of Chemical Reactions
- Chemical Equilibrium
- Radiation Chemistry
- Organic Derivatives and Products

CORE

- 30.1 Enthalpy
- 30.2 Energy Changes
- 30.3 Acids and Bases
- 30.4 Relative Acidity
- 30.5 Acid-Base Reactions
- 30.6 Oxidation and Reduction
- 30.7 Redox Reaction
- 30.8 Electric Potentials of Redox Reactions
- 30.9 Redox Cells as a Source or Consumer of Electrons

Electives*

- Environmental Problems
- Industrial Chemistry and People
- Foods and their Analogues
- Fossil Fuel
- Locally Developed Electives

Time Allocations: about 75 hours for the core topics.
about 45 hours for the elective topics.

*At least two elective areas are to be explored. The outlines are provided in the Curriculum Guide with a list of references.

CHEMISTRY 30

Prescribed Core References

O'Connor, P.R. et al, *Chemistry: Experiments and Principles.*
Toronto: D.C. Heath, 1977

Davis, J.E. et al, *Laboratory Manual for Chemistry: Experiments and Principles.*
Toronto: D.C. Heath, 1977
or:
Jenkins, F. et al, *ALCHEM 30.* Edmonton: E.P.S. District #7, 1977.

or for Acid Base section:

Richardson, R.A., *Proton Chemistry: the Reactions of Acids and Bases.*
Rexdale: Wiley and Son, 1976

Recommended Core References

Parry, R.W. et al, *Chemistry: Experimental Foundations, Second Edition.*
Scarborough: Prentice-Hall, 1975

Metcalfe, H.C. et al, *Modern Chemistry.* Toronto: Holt, Rinehart and Winston, 1974

Young, J.A. and E.W. Ledbetter, *Keys to Oxidation--Reduction.*
Don Mills: Addison-Wesley, 1974

National Science Curriculum Materials Project:
Slattery, R.T., *Acids and Bases*
Langrehr, J.S., *Oxidation and Reduction*
Doherty, J.P., *Energy in Chemical Reactions*
Agincourt: Gage and Co. 1975

Recommended Elective References (in addition to those listed above)

Gordon, G. and W. Zoller, *Chemistry in Modern Perspective.* Don Mills:
Addison-Wesley, 1975

Seager, S.L. and H.S. Stoker, *Chemistry: A Science for Today.*
Agincourt: Gage and Company, 1973

Jones, M.M. et al, *Chemistry, Man and Society, Second Edition.*
Toronto: W.B. Saunders, 1976

Pryde, L.T., *Environmental Chemistry.* Don Mills: Addison-Wesley, 1973

National Science Curriculum Materials Project:
Calcraft, P.M., *The Chemistry of Carbon*
Craven, B., *Principles of Chemical Equilibrium*
Harcourt, R.D., *Chemical Bonding*
Stanley, R.J., *Rates of Chemical Reactions*
Agincourt: Gage and Company, 1975

IAC Modules
Gordon, G., *The Delicate Balance*
Martin, D. and J. Sampugna, *Molecules in Living Systems.*
Don Mills: Fitzhenry and Whiteside (Harper and Row), 1973

TOPICAL OUTLINE OF CHEMISTRY 30 CORE

CHEMICAL ENERGETICS

Concepts:	Subconcepts:	
30.1 Each substance has a definite and characteristic heat content or enthalpy.	30.1.1	The enthalpy of a substance is the sum of the kinetic and potential energy of the molecules.
	30.1.2	The heat of formation is the energy required or released as a substance is formed from its elements.
30.2 Changes in matter involve a change in energy	30.2.1	Changes that require energy are endothermic and those that release energy are exothermic.
	30.2.2	More energy is involved in nuclear changes than in chemical changes, and in general more energy is involved in chemical changes than in phase changes.
	30.2.3	In a phase, chemical, or nuclear change, the change in energy is the energy of the products less the energy of reactants.
	30.2.4	The ΔH of chemical and phase changes is determined calorimetrically.
	30.2.5	By addition of ΔH values for known reactions, ΔH values for new reactions can be predicted.
	30.2.6	The amount of energy released or absorbed in a phase, chemical or nuclear change is related to the number of moles of reactants.

ACIDS AND BASES

Concepts:	Subconcepts:
30.3 Acids and bases can be defined in different ways.	30.3.1 Acids taste sour, change the color of indicators, etc. Bases taste bitter, change the color of indicators, etc.
	30.3.2 Acids neutralize bases.
	30.3.3 Arrhenius defined acids as those substances that increase the $H_3O^+(aq)$ concentration and bases as those that increase the OH^- (aq) concentration.
	30.3.4 Bronsted and Lowry defined acids as proton donors and bases as proton acceptors.
30.4 The relative acidity of a solution can be measured.	30.4.1 The strengths of acids and bases vary and are a measure of the equilibrium condition.
	30.4.2 The pH scale is a measure of the H_3O^+ (aq) concentration.
	30.4.3 Indicator color may be used to determine pH.
30.5 Acid-base reactions involve an exchange of protons.	30.5.1 An acid-base reaction can be represented by a net ionic equation.
	30.5.2 The relative strength of bases can be used to predict the equilibrium conditions.
	30.5.3 Titration is one of the main techniques used in quantitive measurement of acid-base reaction.
	30.5.4 The determination of quantitative relationships in acid-base reactions is part of stoichiometry.

OXIDATION-REDUCTION

Concepts:	Subconcepts:
30.6 Redox reactions involve an exchange of electrons.	30.6.1 Oxidation is defined as the loss of electrons. Reduction is defined as the gain of electrons.
	30.6.2 Oxidizing agents cause oxidation and reducing agents cause reduction to occur.

		30.6.3	A redox reaction can be represented by a net ionic equation.
30.7	In a redox reaction the electron loss and gain must balance.	30.7.1	Oxidation numbers or half-reactions illustrate the loss and gain of electrons.
		30.7.2	Oxidation numbers or half-reactions may be used to balance equations.
		30.7.3	Titration is one of the main techniques used in quantitative measurement of redox reactions.
		30.7.4	The determination of quantitative relationships in redox reactions is part of stoichiometry.
30.8	The electrical potential of a redox reaction can be predicted and measured.	30.8.1	Reduction potentials are relative potentials of reduction half-reactions.
		30.8.2	Oxidation potentials are negative reduction potentials.
		30.8.3	The relative strengths of oxidizing and reducing agents are compared in terms of a table of reduction potentials.
		30.8.4	The net potential of a redox reaction is the sum of the oxidation and reduction potentials.
		30.8.5	The spontaneity of a redox reaction can be predicted from the relative strengths of the oxidizing agents or from the positive sign of the net potentials.
30.9	Redox reactions involve electrical energy.	30.9.1	Electrochemical cells convert chemical energy to electrical energy.
		30.9.2	Electrolytic cells are used to convert electrical energy to chemical energy.
		30.9.3	There are many applications of electrochemical and electrolytic cells.

CONCEPT REFERENCE GRID KEYED TO PRESCRIBED REFERENCES

CHEMICAL ENERGETICS

	CONCEPTS		SUBCONCEPTS	Chemistry: Experiments & Principals	Objectives	ALCHEM	Objectives
30.1	Each substance has a definite and characteristic heat content or enthalpy.	30.1.1	The enthalpy of a substance is the sum of the kinetic and potential energy of the molecules.	pp 232-234	1,2	L5, L9, L17	2
		30.1.2	The heat of formation is the energy required or released as a substance is formed from its element.	225-230	1,2	L27	2
30.2	Changes in matter involve a change in energy	30.2.1	Changes that require energy are endothermic and those that release energy are exothermic.	pp 225-226	1,2	L2-L4, L17-L19 Labs L1 & L2	1, 2, 4
		30.2.2	More energy is involved in nuclear changes than in chemical changes, and in general more energy is involved in chemical changes than in phase changes.	233-240	1,2	L1-L5, L33-L35	1, 2, 4, 6
		30.2.3	In a phase, chemical, or nuclear change, the change in energy is the energy of the products less the energy of reactants.	pp 84-95 p 226 p 232-234	1,2	L8-L9 L17-L19 L33	1,2
		30.2.4	The ΔH of chemical and phase changes is determined calorimetrically.	p 222-230 Exp.25,26, & 27		Labs L1 & L2 L6-L16 L20-L23	1,2, 4, 6
		30.2.5	By addition of ΔH values for known reactions, ΔH values for new reactions can be predicted.	222-224 pp 227-229 Exp.27	1,2,4	L24-L29 L30,L35,L36 L38	1,2, 4
		30.2.6	The amount of energy released or absorbed in a phase, chemical or nuclear change is related to the number of moles of reactants.	p 221-242	1,2,3,4	L10-L11, L27-L32 Labs L1 & L2	1,2,4,6

							PROTON CHEMISTRY	
30.3	Acids and bases can be defined in different ways.	30.3.1	Acids taste sour, change the color of indicators, etc. Bases taste bitter, change the color of indicators, etc.	pp 288-290	2,3,4	N 1 Demo 1	1,2	pp 16-20	1,2,4
		30.3.2	Acids neutralize bases.	290-291-292 Exp 31	1,2,4	N1, Demo N4	1, 2	pp 20-22 32-35 82,87-89	1,2,4,7
		30.3.3	Arrhenius defined acids as those substances that increase the H_3O^+ (aq) concentration and bases as those that increase the OH^- (aq) concentration.	pp 290-295	1,2,4	N4	2	pp 29-31, 36	2,6
		30.3.4	Bronsted and Lowry defined acids as proton donors and bases as proton acceptors.	pp 298-300 Ep 34	1,2,4,6	N4-N6 N8-N11 Lab N1	1,2,6	pp 29-31 36	2,6
30.4	The relative acidity of a solution can be measured.	30.4.1	The strengths of acids and bases vary and are a measure of the equilibrium condition.	pp 293-294 300 - 306 Exp 33	1, 2	N 20-N25 Demo N3	1,2	pp 40-49 52-57	1, 2
		30.4.2	The pH scale is a measure of the H_3O^+ (aq) concentration.	P 297-298	1,2,3	N7-N19,N57, N58, N60 Demos N2, N3	1,2,3,4	pp 60-62	2,7
		30.4.3	Indicator color may be used to determine pH.	P297 Exp 33	2,4	N4,N47-N48, N53	1,2	Pp 62-69	1,2,7
3.5	Acid-base reactions involve an exchange of protons	30.5.1	An acid-base reaction can be presented by a net ionic equation.	P 291-294 p 298-300	1,2,4	entire unit	1,2,4,5,6		
		30.5.2	The relative strength of bases can be used to predict the equilibrium conditions.	p 300-307	1,2	N26-N61	1,2,4		
		30.5.3	Titration is one of the main techniques used in quantitative measurement of acid-base reaction.	pp 293-298 Exp 32	1,2	N39-N55 Demo N4 Lab N2	1,2,4	Pp 82-88	1,2,4,7
		30.5.4	The determination of quantitative relationships in acid-base reactions is part of stoichiometry.	P 291-309	1,2	N39-N53 N58-N61 Lab N2	1,2,4		

	CONCEPTS		SUBCONCEPTS	Chemistry: Experiments & Principles	Objectives	ALCHEM	Objectives
30.6	Redox reactions involve an exchange of electrons.	30.6.1	Oxidation is defined as the loss of electrons. Reduction is defined as the gain of electrons.	P 310-313 P 320-322 Exp. 35	1,2	M6-M8	1,2
		30.6.2	Oxidizing agents cause oxidation and reducing agents cause reduction to occur.	p 314-318	2	M6-M8	1,2
		30.6.3	A redox reaction can be represented by a net ionic equation.	P 312-346 Exp. 35	1,2,3	Lab M1 M6, M8	1, 2
30.7	In a redox reaction the electron loss and gain must balance.	30.7.1	Oxidation numbers or half-reactions illustrate the loss and gain of electrons.	PP338-341 P 318-P320	2	M6-M8	2
		30.7.2	Oxidation numbers or half-reactions may be used to balance equations.	P 334-341	1,2	M6-M14	1,2
		30.7.3	Titration is one of the main techniques used in quantitative measurement of redox reactions.	P 316-318	1,2,4,7	Lab M2 M17, M22	1,2,4
		30.7.4	The determination of quantitative relationships in redox reactions is part of stoichiometry.	P 324-328 P 332-334 Exp. 36	1,2,4	M15-M23 M59, M68 Lab M2	1,2
30.8	The electrical potential of a redox reaction can be predicted and measured.	30.8.1	Reduction potentials are relative potentials of reduction half-reactions.	P 324-326	2	M8,M26 Lab M3	1,2
		30.8.2	Oxidation potentials are negative reduction potentials.	P 324	2	M8,M26 M39	2
		30.8.3	The relative strengths of oxidizing and reducing agents are compared in terms of a table of reduction potentials.	P 326-327	2	M8-M10 M39,M48,M60 Lab M1	2
		30.8.5	The spontaneity of a redox reaction can be predicted from the relative strengths of the oxidizing agents or from the positive sign of the net potentials.	Pp 324-327 Exp. 38	1 2,7	M9-M14,M33 M61-M62, Labs M1,M2 + M3 Demo. M1	1,2,4,7
30.9	Redox reactions involve electrical energy.	30.9.1	Electrochemical cells convert chemical energy to electrical energy.	P 327-329 P 322-324	2,4	M24-M38 M63-M64 Lab M3	1,2,4,7
		30.9.2	Electrolytic cells are used to convert electrical energy to chemical energy.	P 330-332 Exp.37	2,4,7	M39-M59 Demo. M1	1,2,3,4,6
		30.9.3	There are many applications of electrochemical and electrolytic cells.	P 332-334 P 341-342	2,4,7	M33-M38 M56-M59 M63-M64	4,6

Chemistry 30
Electives

CHEMISTRY 30 ELECTIVE MODULES

The listing of these modules is not intended to be very extensive or exclusive. The teacher is quite free to use other ideas or elective modules.

The principles underlying the choice of modules are:

1. The time available is of the order of 65 to 70 hours.

2. The content is to be related to the core in one of three ways:

   a. an extension of a core topic
   b. an indepth, intensive study of a core topic, or
   c. a practical application of a core topic

Elective topics are to be chosen from the following list. A minimum of two topics are to be studied.

30.1 Rates of Chemical Reactions . . . . . p. 55

30.2 Chemical Equilibrium. . . . . p. 56

30.3 Radiation Chemistry . . . . . p. 57

30.4 Organic Derivatives and Products. . . p. 58

30.5 Environmental Problems. . . . . p. 59

30.6 Industrial Chemistry. . . . . p. 60

30.7 Foods and Their Analogues . . . . . p. 61

30.8 Fossil Fuel . . . . . p. 62

30.9 Locally Developed Unit

Rates of Chemical Reactions

INTENT

To have students:
Obtain an introduction to the two major aspects of chemical kinetics. The factors that determine reaction rates, and the role that energy plays in the rates of reactions.

CONTENT

1. Reaction mechanisms
2. Concentration
3. Collision theory
4. Kinetic energy and temperature
5. Activation energies
6. Catalysts

REFERENCES

1. O'Connor, P. R. et al, *Chemistry: Experiments and Principles*. Toronto: D. C. Heath, 1977, Chapter 12.
2. Stanley, R. J., *Rates of Chemical Reactions*. Agincourt: Gage, 1975.
3. Parry, R. W. et al, *Chemistry: Experimental Foundations. Second Edition*. Scarborough: Prentice-Hall, 1975, Chapter 10.

Chemical Equilibrium

INTENT

To have students:
Obtain an intensive introduction to the concept of equilibrium in chemical systems.

CONTENT

1. The dynamic nature of equilibrium
2. The meaning of equilibrium in a chemical system
3. The equilibrium constant expression and units of K_c
4. An application of the equilibrium constant to understanding the effect of concentration, pressure and temperature changes on equilibrium
5. Two special cases of equilibrium - K_{sp} and K_w

REFERENCES

1. O'Connor, P. R. et al, *Chemistry: Experiments and Principles*. Toronto: D. C. Heath, 1977, Chapter 13.
2. Parry, R. W. et al, *Chemistry: Experimental Foundations. Second Edition*. Scarborough: Prentice-Hall, 1975, Chapters 11, 12 and 13.
3. Craven, B., *Principles of Chemical Equilibrium*. Agincourt: Gage, 1975.

Radiation Chemistry

INTENT

To have students:
Obtain a basic knowledge of fundamental particles, nuclear reactions and applications of nuclear science.

CONTENT

1. Basic properties of matter
2. Radioactive decay
3. Mans use of radiation

REFERENCES

1. Gordon, G. and W. Zoller, *Chemistry in Modern Perspective*. Don Mills: Addison-Wesley, 1975, Chapters 4, 5 and 6, pp 41-100.
2. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today*. Agincourt: Gage & Co., 1973, Chapter 16.
3. Viola, V., *The Heart of Matter*. Don Mills: Fitzhenry and Whiteside (Harper and Row) 1973.
4. Whitman, R. L. and E. E. Zinck, *Chemistry Today*. Scarborough: Prentice Hall, 1976, Chapter 16.
5. Vallarino, L. M. and J. V. Quagliano, *Chemistry: A Humanistic Approach*. Toronto: McGraw-Hill, 1975, Chapter 5, pp 103-134.
6. Jones, M. M. et al, *Chemistry, Man and Society, Second Edition*. Toronto: W. B. Saunders, 1976, Chapter 24.

Organic Derivatives and Products

INTENT

To have students:
Acquire a further knowledge of the field of carbon chemistry than that experienced in the chemistry 20 core.
Reach an understanding of the importance of organic compounds in everyday life.

CONTENT

1. Nomerclature
2. Isomers
3. Aromatic compounds
4. Synthetic compounds
5. Fats, oils, soaps
6. Ethers, aldehydes and ketones
7. Organo-sulfur and organo-nitrogen compounds
8. Halogenated hydrocarbons, pesticides and poly chlorinated biphenyls
9. Polymers and plastics

REFERENCES

1. Gordon, G. and W. Zoller, *Chemistry in Modern Perspective*. Don Mills: Addison-Wesley, 1975, Chapter 13.
2. Jones, M. M. et al, *Chemistry, Man and Society, Second Edition*. Toronto: W. B. Saunders, 1976. Chapter 13, 14 and 15, plus 21 and 23.
3. O'Connor, P. R. et al, *Chemistry: Experiments and Principles*. Toronto: D. C. Heath, 1977, Chapter 16.
4. Parry, R. W. et al, *Chemistry: Experimental Foundations, Second Edition*. Scarborough: Prentice-Hall, 1975. Chapter 19.
5. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today*. Agincourt: Gage and Co., 1973, Chapters 17, 18, 19 and 20.

Environmental Problems

INTENT

To have students:
Experience an awareness and arrive at an understanding of the problems that arise from the dispersal of products from chemical reactions that support our life styles.

CONTENT

The major content should relate to the chemistry of major problems that face us in the preservation of our environment.

1. Conservation of non-renewable resources:
   - recycling metals
   - increasing use of renewable energy resources
   - role of energy factors in the environment
2. Man's effect on the environment:
   - greenhouse effect
   - atmospheric particles
   - weather modification activities
   - metals in the environment
   - photo-chemical smog
   - thermal pollution
3. Natural processes that degrade the environment:
   - entrophication
   - producers, consumers and decomposers in a renewing cycle
   - the second law of thermo dynamics -- the down-hill slide

REFERENCES

1. Gordon, G. and W. Zoller, *Chemistry in Modern Perspective.* Don Mills: Addison-Wesley, 1975, chapters 4, 9, 10-8, 10-9, 12-6, 12-7, 12-8, 12-9, 14-3, 14-4, 14-6.
2. Whitman, R. L. and E. E. Zinck, *Chemistry Today.* Scarborough: Prentice-Hall, 1976, chapter: 14-16, 14-17, 14-20, 15 (all).
3. Vallarino, L. M. and J. V. Ouagliano, *Chemistry: A Humanistic Approach.* Toronto: McGraw-Hill, 1975, chapter 18.
4. Gordon, G., *The Delicate Balance.* Don Mills: Fitzhenry and Whiteside (Harper & Row), 1973.
5. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today.* Agincourt: Gage and Co., 1973, Chapters 21 and 22.

Industrial Chemistry and People

INTENT

To have students:
Realize the magnitude of chemical reactions in our economic systems and the roles played by people in those industries built around specific chemical reactions.

CONTENT

1. Industrial processes that are based on chemical reactions: paints, metals and production fibers, paper, etc.
2. Raw materials to finished products - what are the reactions?
3. Products - both useful and not useful.

REFERENCES

1. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today*. Agincourt: Gage & Co., 1973, chapter 13, 14 and 15.
2. Vallarino, L. M. and J. V. Quagliano, *Chemistry: A Humanistic Approach*. Scarborough: McGraw-Hill, 1975, Chapter 15, 16 and 17.

Foods and Their Analogues

INTENT

To have students:
Become acquainted with the basic structure, classification, and use of foods to the point where the students can understand and evaluate basic reactions, both in the formation and use of food compounds.

CONTENT

1. Lipids
2. Polymerization
3. Proteins
4. Carbohydrates

REFERENCES

1. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today*. Agincourt: Gage & Co., 1973, Chapter 23 and 24.
2. Jenkins, F. et al, *ALCHEM 30, Unit O, Foods and Their Analogs*. Edmonton: EPSB, 1977.
3. Vallarino, L. M. and J. V. Quagliano, *Chemistry: A Humanistic Approach*. Toronto: McGraw-Hill, 1975, Chapter 13, particularly pp 326-342.

Fossil Fuels as a Source of Energy

INTENT

To have students:
Arrive at deeper understanding of the dependency of our North American life style upon a non-renewable resource.

CONTENT

1. Petroleum, natural gas and coal as an energy resource
2. Fossil fuels as a source of pollution
3. Fossil fuels as a chemical feed stock

REFERENCES

1. Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today*. Agincourt: Gage and Co., 1973, Chapter 19.
2. Jenkins, F., *ALCHEM 30, Unit R, Gasoline: Unit OS, Oil Sands*. Edmonton: EPSB, 1977.
3. Gordon, G. and W. Zoller, *Chemistry in Modern Perspective*. Don Mills: Addison-Wesley, 1975, Chapter 14.
4. Vallarino, L. M. and J. V. Quagliano, *Chemistry: A Humanistic Approach*. Scarborough: McGraw-Hill, 1975. Chapter 14.
5. Jones, M. M. et al, *Chemistry, Man and Society, Second Edition*. Toronto: W. B. Saunders, 1976, Chapter 25.

Print Resources

CLASSROOM RESOURCES FOR TEACHER USE

There is a wealth of print and non-print resources available for the teacher to use in presenting the chemistry program. However, the rate at which non-print resources become available or unavailable requires a catalogue service. This is available through the system I.M.C.'s and the regional film libraries.

An important source of information relating to the use of various available programs is contained in the teacher's guides that accompany the recommended text resources.

The print resource materials that most teachers will find useful are described on the next few pages.

SUPPORT MATERIAL RECOMMENDED FOR CHEMISTRY

CHEMISTRY 10-20

Primary Core References

Ledbetter, E. W. & J. A. Young, *Keys to Chemistry.*
Don Mills: Addison-Wesley, 1977

_____, _____, *Keys to Organic Chemistry.*
Don Mills: Addison-Wesley, 1977

_____, _____, *Laboratory Keys to Chemistry.*
Don Mills: Addison-Wesley, 1977

Recommended text for the majority of students. The objectives are stated at the beginning of each chapter, with practice problems and exercises at the end. A laboratory manual, and a teachers' guide is available.

Jenkins, F. et al, *ALCHEM 10*, Edmonton: E.P.S. District #7, 1977

_____, *ALCHEM 20*, Edmonton: E.P.S. District #7, 1977

A series of units - some core and others elective that have been developed by members of the Edmonton Regional Chemistry Council. The writers have attempted to integrate the practical applications with the theoretical chemistry. The units used are SI and are consumable.

Secondary Core References

Courneya, D. and H. McDonald, *The Nature of Matter*,
Toronto: D. C. Heath, 1976

This text is a rewrite of *A Model for Matter* at a slightly higher reading level - more detail is presented and the units used are SI - the text has the metric commission's symbol. The laboratory exercises are included in the book and there is more material than most teachers could use in presenting the core concepts.

Whitman, R. L. and E. E. Zinck, *Chemistry Today*,
Scarborough: Prentice-Hall, 1976

An introductory text with a laboratory manual that has more detail than most chemistry teachers will want to use. Objectives are clearly stated at the beginning of each chapter and a good selection of problems reviews the concepts covered. The units are SI and the text has the Metric Commission's symbol.

IAC Modules:

Atkinson, G. and H. Heikkinen, *Reactions and Reason*,

Huheey, J. *Diversity and Periodicity*,

DeVoe, H. *Communities of Molecules*,

Jarvis, B. & P. Mazzocchi, *Form and Function*,
Don Mills: Fitzhenry and Whiteside (Harper and Row), 1973

The first module serves as an introduction to chemistry in an eight-week mini-course. It explores most of the important chemical concepts. The other modules delve into the field of inorganic chemistry, organic chemistry, biochemistry, physical chemistry, nuclear chemistry and environmental chemistry, which can serve as resources for elective explorations in the balance of the program. The text uses metric units but is not totally SI.

Elective References (In addition to those listed above)

Darlington, C. LeR. and H. D. Eigenfeld, *The Chemical World: Activities and Explorations*. Markham: Houghton Mifflin, 1977

A textbook written for the average grade 10 student. It emphasizes basic skills and concepts with a minimal amount of computation and a maximum of student activity. Practical applications of the basic skills and concepts form an important part of this text. The units are not SI but are MKS. The historical references are interesting and provide a human backdrop to the study of chemistry. The activities provide useful material for a practical applications unit in chemistry.

Vallarino, L. M. and J. M. Quagliano, *Chemistry: A Humanistic Approach*, Toronto: McGraw-Hill, 1975

This text is well illustrated and covers the subject matter quite well, there is considerably more material than is needed for the core, and it contains enough material for a number of interesting elective modules. It is not SI and does not have any laboratory component.

Ashcroft, K., *Action Chemistry*, Agincourt: Book Society, 1974

A very useful and interesting approach to chemistry. This text has more than enough material for the core and elective program in grade 10. The units are SI and the laboratory exercises are included. The book is written for the average student in grade 10.

Ashcroft, K. and J. Hammil, *Chemistry of the Car*, Agincourt: Book Society, 1976

An interesting application of carbon chemistry combined with the physical chemistry involved in the operation of an automobile. It fits nicely as a resource for an elective module in the Chemistry 20 program.

Ashcroft, K., *Chemistry of Photography*, Agincourt: Book Society, 1976

An examination of the chemistry involved in taking a picture and developing the film. An excellent resource for a practical elective module in Chemistry 20.

Hammil, J., *Water, Chemistry & Ecology*, Agincourt: Book Society, 1974

An extremely interesting study of the chemistry of water and the role it plays in life-processes on this planet. A good resource for an elective module in chemistry 20.

Birenbaum, L., *Chemistry of Man & Molecules*, Agincourt: Book Society, 1975

An interesting study of the action of drugs on the human system including medication, mind-altering drugs and common household products. A good resource for an elective module in Chemistry 20.

Pryde, L. T., J. A. Young, & E. W. Ledbetter, *Keys to Environmental Chemistry*, Don Mills: Addison-Wesley, 1975

A module of the *Keys to Chemistry* program that deals experimentally with the two resources (air and water) that are important in determining the quality of our environment. It leads students in a study of environmental problems from an understanding of the basic concepts of chemistry. The objectives are clearly stated in the module which is an excellent resource for a chemistry 20 elective unit.

Teacher References (In addition to teachers editions and guides to texts listed above)

Jones, M. M. et al, *Chemistry, Man and Society, Second Edition*, Toronto: W. B. Saunders, 1976

In this presentation, chemical theory is shown as a continuing development of conceptual ideas about the world of atoms and molecules rather than as a set of "facts" to be learned. One continuing thread throughout the program is the energy question -- particularly that of energy management. This material is an excellent resource of useful ideas for the chemistry.

Cummings, J. D. and M. A. Wartell, *Introduction to Chemistry*, Rexdale: Wiley, 1975

A text that is well illustrated, has specific objectives for each chapter and the associated practice problems. Aimed at students with a limited mathematics background it covers the main points in the program.

Kavanah, P., J. Robbins and J. Oberkrieser, *Concepts in Modern Chemistry*, New York: Cambridge Book (Gage) 1975

An encyclopedic compendium of all that you would want to know about chemistry - even more than you would want to know. It is available in soft- and hard-cover and is revised regularly as new ideas emerge. The kind of book that you want to have as a reference.

Kowalski, S. W., *Consumer Science*, Dubuque, Iowa: Kendall/Hunt, 1975

This text-lab manual is a combination of consumer information about commonly purchased products and 40 laboratory exercises that help the student investigate product claims and efficacy. These exercises are not subject specific but all involve good technique in both Chem 10 and 20 and can be used to give a theoretical course a more practical flavour.

Thomson, T. R., *Ideas from Chemistry*,
Don Mills: Addison-Wesley, 1973

A paper-back resource that provides background information to the Chemistry 10 and 20 core topics. Useful for an independent reading assignment.

CHEMISTRY 30

Primary Core References

O'Connor, P. R. et al, *Chemistry: Experiments and Principles*,
Toronto: D. C. Heath, 1977

A revision of a program developed from the CHEM Study program. This is an excellent treatment of the fundamental ideas in Chemistry presented as an inquiry-based laboratory program. The text has a grade 11 reading level. The teacher's guide provides an excellent aid for chemistry teachers.

Davis, J. E. et al, *Laboratory Manual for Chemistry: Experiments and Principles*, Toronto: D. C. Heath, 1977

In a consumable format, the lab manual is well integrated with the text.

Jenkins, F. et al, *ALCHEM 30*, Edmonton: E.P.S. District #7, 1977

The *ALCHEM* materials include both core and elective materials. The core materials are purchased as three-hole-punched, plastic wrapped separate packages for each of *ALCHEM 10*, *20* and *30*. The elective materials are purchased as separate individual units. All of the core and elective units contain the textual, laboratory and exercise materials within the single package.

Richardson, R. A., *Proton Chemistry: The Reactions of Acids and Bases*,
Rexdale: Wiley, 1976

This module is an excellent resource for the core unit dealing with acids and bases. The experiments and activities are geared to the objectives of the chemistry 30 program. This module is part of a series of modules being edited by D. A. Humphreys and A. C. Blizzard. The series is made for and by Canadian authors. Other units are in the developmental stage and will be examined as they become available.

Secondary Core References

Parry, R. W. et al, *Chemistry: Experimental Foundations*, Second Edition, Scarborough: Prentice-Hall, 1975

A revision of a program developed from the CHEM Study program. With the laboratory manual it is an excellent presentation of the fundamental ideas in chemistry. It is probably the most challenging of the CHEM Study texts in both reading level and conceptual presentation. It has more than enough material to serve as a basic resource for the Chemistry 30 program for an above-average group of university-bound students. The units are not SI.

Metcalfe, H. C. et al, *Modern Chemistry*, Toronto: Holt Rinehart & Winston, 1974

This text presents a comprehensive discussion of the fundamental theory behind chemistry and an introduction to some descriptive chemistry. The text has a readability index of late 7th grade and includes ample material for the core program but only some of the more theoretical electives.

Young, J. A. and E. W. Ledbetter, *Keys to Oxidation - Reduction*, Don Mills: Addison-Wesley, 1974

A module of the *Keys to Chemistry* program. The module provides an excellent sequence of laboratory exercises for the core unit on Red-ox. The objectives are very explicit and most students will enjoy the suggested treatment of this subject.

National Science Curriculum Materials Project Modules:

Slattery, R. T. *Acids and Bases.*

Langrehr, J. S. *Oxidation and Reduction.*

Doherty, J. P. *Energy in Chemical Reactions*, Agincourt: Gage & Co. 1975

This set of booklets from Australia provides a comprehensive coverage of the Chemistry 30 program as outlined, (both the core and elective) for the above average student. The materials include a paperback booklet, a set of practical activities and a set of tests.

Elective References (In addition to those listed on previous page)

Gordon, G. and W. Zoller, *Chemistry in Modern Perspective*, Don Mills: Addison-Wesley, 1975

This text is based on the theme of how can chemistry be used to enhance the quality of life. Mathematical requirements are kept to a bare minimum but there is enough material on stoichiometry, gas laws, equilibria, etc., that a more quantitative approach is possible. Part of the grade twelve core and a number of electives could be based on this text.

Seager, S. L. and H. S. Stoker, *Chemistry: A Science for Today.* Agincourt: Gage & Co. (Scott Foresman), 1973

An up-to-date, informative text resource that discusses the background chemistry and current topics in chemistry from a rather non-technical point of view. Good supplementary resource for Chemistry 30 core and electives.

Jones, M. M. et al, *Chemistry, Man and Society, Second Edition*, Toronto: W. B. Saunders, 1976

This text presents chemical theory as a continuing development of conceptual ideas about the world of atoms and molecules rather than as a set of "facts" to be learned. One continuing thread throughout the program is the energy question -- particularly that of energy management. This material is a particularly good resource for chemistry 30 electives.

Pryde, L. T., *Environmental Chemistry*, Don Mills: Addison-Wesley (Cummings), 1973

An interesting approach to applied chemistry. The pilot teachers found that a few of the experiments called for chemicals and procedures that are not normally in high school chemistry programs. The materials are available as a hard cover text with a laboratory manual and some chapters are bound separately as soft-cover units (Air Pollution, Water Pollution and Pesticides, Foods and Drugs).

National Science Curriculum Materials Project Modules:

Calcraft, P. N., *The Chemistry of Carbon.*

Craven, B., *Principles of Chemical Equilibrium.*

Harcourt, R. D., *Chemical Bonding.*

Stanley, R. J., *Rates of Chemical Reactions,*
Agincourt: Gage & Co., 1975

This set of booklets from Australia provides a comprehensive coverage of the Chemistry 30 program as outlined, (both the core and elective) for the above average student. The materials include a paperback booklet, a set of practical activities and a set of tests.

IAC Modules:

Gordon, G., *The Delicate Balance.*

Viola, V., *The Heart of Matter.*

Martin, D. and J. Sampugna, *Molecules in Living Systems,*
Don Mills: Fitzhenry and Whiteside (Harper & Row), 1973

IAC is a modular chemistry program consisting of seven separate modules in the areas of physical chemistry, organic chemistry, biochemistry, inorganic chemistry, nuclear chemistry and environmental chemistry.

The intent of the program is to present relevant and interesting chemistry that emphasizes the interrelationships between the sciences.

Teacher References (In addition to the teachers editions and guides to texts listed above)

Henry, N. W. et al, *Matter Under Investigation,*
Agincourt: Gage (Jacaranda), 1975

An Australian text written by a group of teachers for their particular situation. The text contains more material than is needed for the Alberta Chemistry program and provides a good resource for both the core and elective modules. It uses SI units throughout.

Toon, E. R. and G. L. Ellis, *Foundations of Chemistry*, 2nd edition. Toronto: Holt, Rinehart and Winston, 1973

A very comprehensive text that provides ample opportunity to explore a wide variety of topics. This text attempts to provide both a traditional approach to chemistry as well as a laboratory based program that is discovery oriented with respect to concepts and principles. In trying to cover all approaches, the text has become a very large and comprehensive tome. It does not use SI units of measure.

Cotton, F. A. et al, *Chemistry: An Investigative Approach, Revised Edition*, Markham: Houghton Mifflin, 1976

This is a revision of a program that was developed from the CHEM Study program. The text is quite comprehensive in scope and includes the laboratory exercises. The teacher's guide is an excellent source of teaching ideas, background information, additional resources, and test items. Some attempt is made to use SI units and symbols. The content is more than adequate for the Chem 30 program. For the university-bound student this text is an excellent resource.

Moran, J. M., M. D. Morgan and J. H. Wiersma, *An Introduction to Environmental Sciences*, Toronto: Little Brown, 1973

An interdisciplinary approach to the study of environmental problems. Presents an integration of physical and biological concepts to examine problems of living on this planet.

Kavanah,P., J. Robbins & J. Oberkrieser, *Concepts in Modern Chemistry*, Agincourt: Gage & Co. (Cambridge), 1975

An encyclopedic compendium of all that you would want to know about chemistry - even more than you would want to know. It is available in soft- and hard-cover and is revised regularly as new ideas emerge. The kind of book that you want to have as a reference.

Kowalski, S. W., *Consumer Science*, Dubuque, Iowa: Kendall/Hunt, 1975

This text-lab manual is a combination of consumer information about commonly purchased products and 40 laboratory exercises that help the student investigate product claims and efficacy. These exercises are not subject specific but all involve good technique in both Chem 10 and 20 and can be used to give a theoretical course a more practical flavour.

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